SECTION II.—GENERAL METEOROLOGY.

NOTES ON THE CLIMATE OF FRANCE AND BELGIUM.

551.58(44)(493)

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[Climatological Division, Weather Bureau, November 12, 1917.]

Introduction.

The present interest of the people of the United States in matters pertaining to Europe has extended to questions of climate and the probable effect of the weather upon the health and comfort of those who have been or who may be called for service in France and Belgium. Numerous inquiries relating to weather conditions usually experienced in those countries have been received, and it seems proper to present to the public at this time a description of their more important climatic features. As there is generally shown on the part of the inquirer a desire for comparisons between weather here and there, sufficient data have been included to permit of such comparisons being made.

Geographical position.—France and Belgium together occupy that portion of the western coast of Europe extending from north latitude 42° 20′ to 51° 20′, which corresponds nearly to the portion of the American coast lying between Boston and the northern end of Newfoundland. In longitude they extend from 4° 42′ west of Greenwich to 7° 30′ east. Their outlines and some of the more important topographic features, including river systems, and locations of various towns are shown on figure 1.

The geographical location of France and Belgium with respect to latitude and their areas as compared with the United States are shown on figure 2, where their outlines are superposed on a chart of the United States and portions of Canada. By referring to this chart it will be seen that in latitude these countries lie largely to the north of the United States. Marseille, the most southerly important city of France, is seen to be farther north than Boston, while Paris is nearly 500 miles farther north than Chicago. Brussels, in latitude 50° 51′, is more than 50 miles farther north than Winnipeg, Canada, or in the same latitude as the southern portion of Hudson Bay. The difference in longitude is such that local time at Paris is approximately five hours later than at New York, that is, when it is noon at New York it is

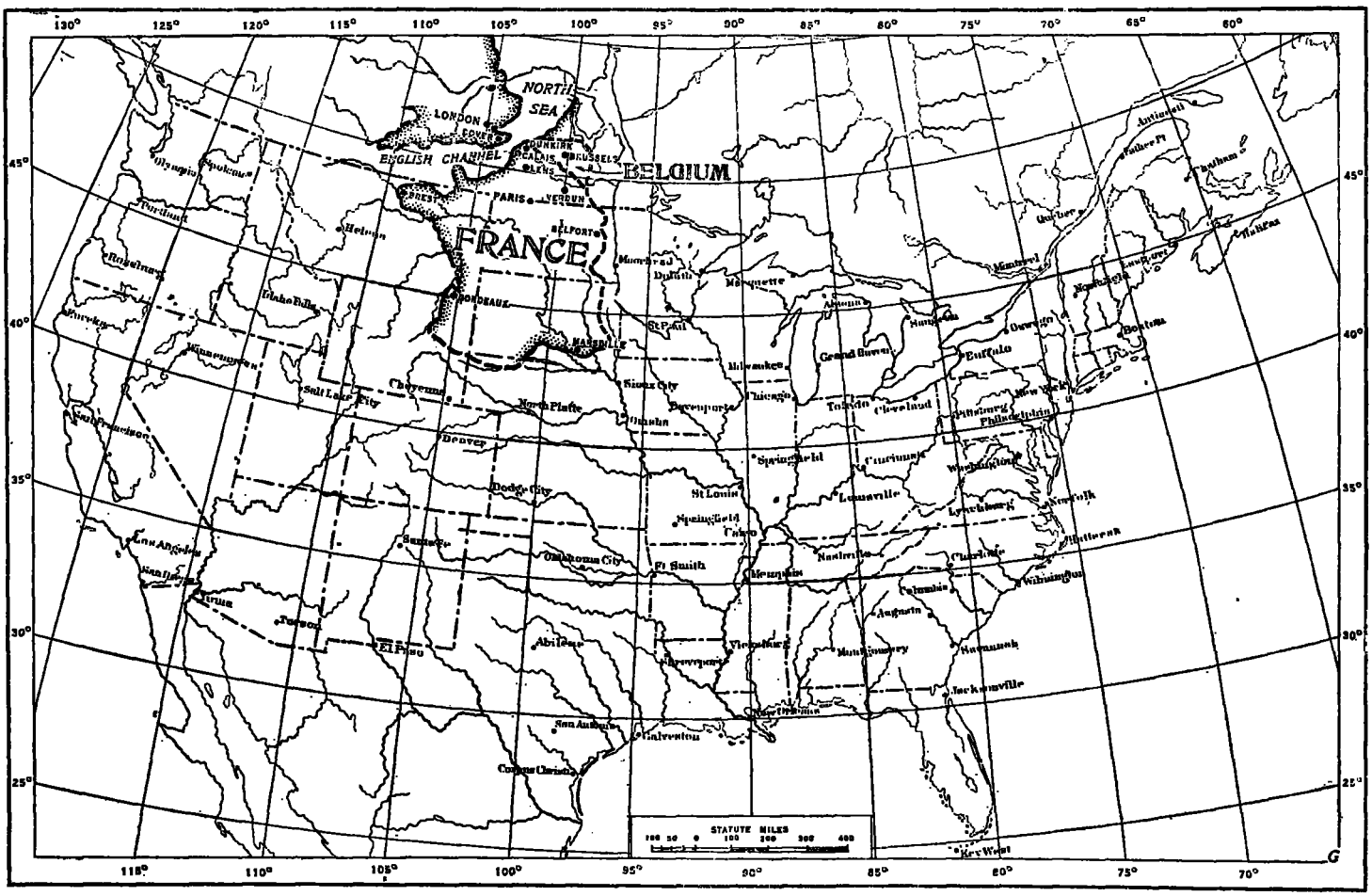

FIG. 2.—Map comparing the relative areas and geographic latitudes of France-Belgium and the United States of North America.

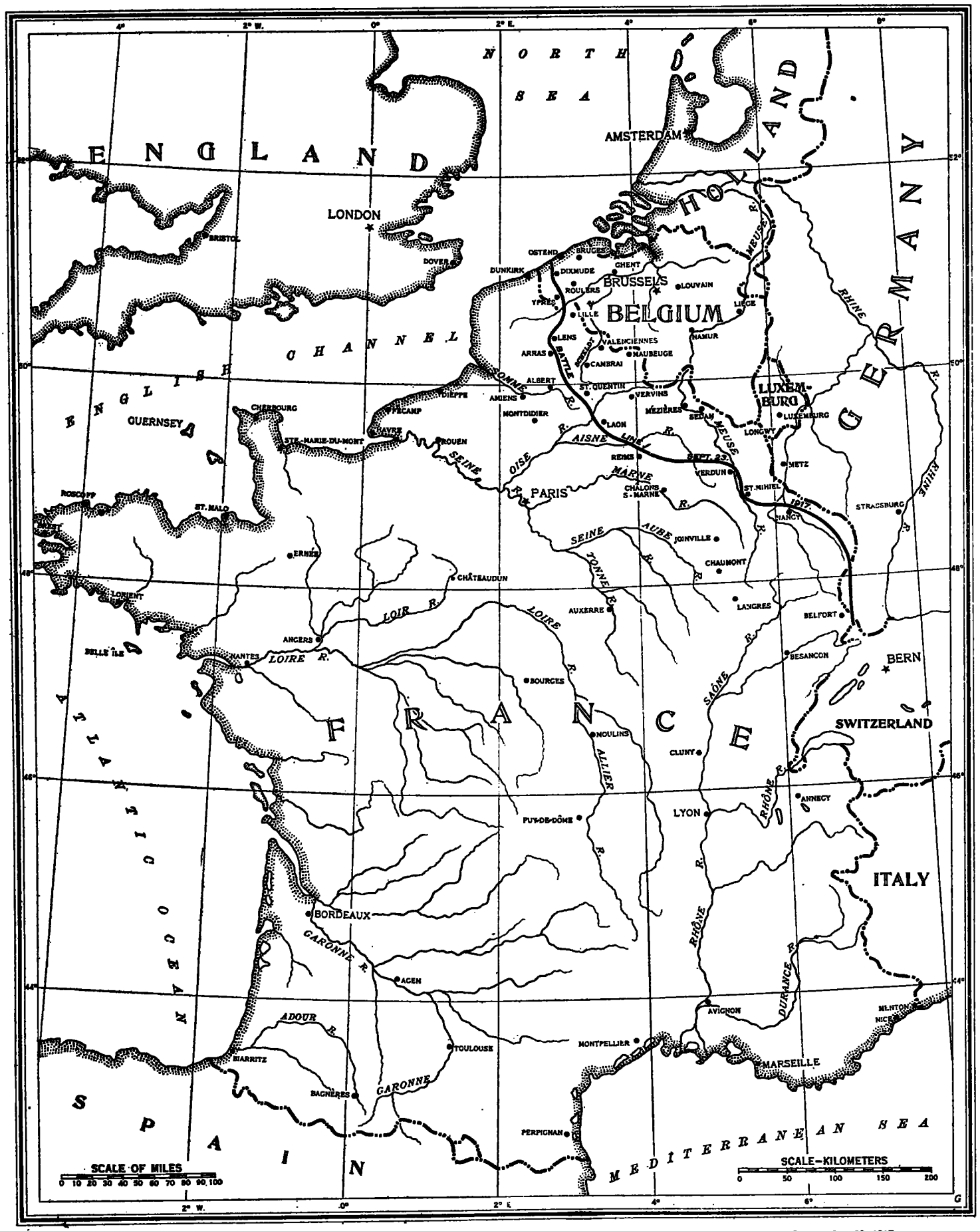

FIG. 1.—Map of France and Belgium, showing rivers, localities referred to in accompanying tables, and approximate battle line on September 23, 1917.

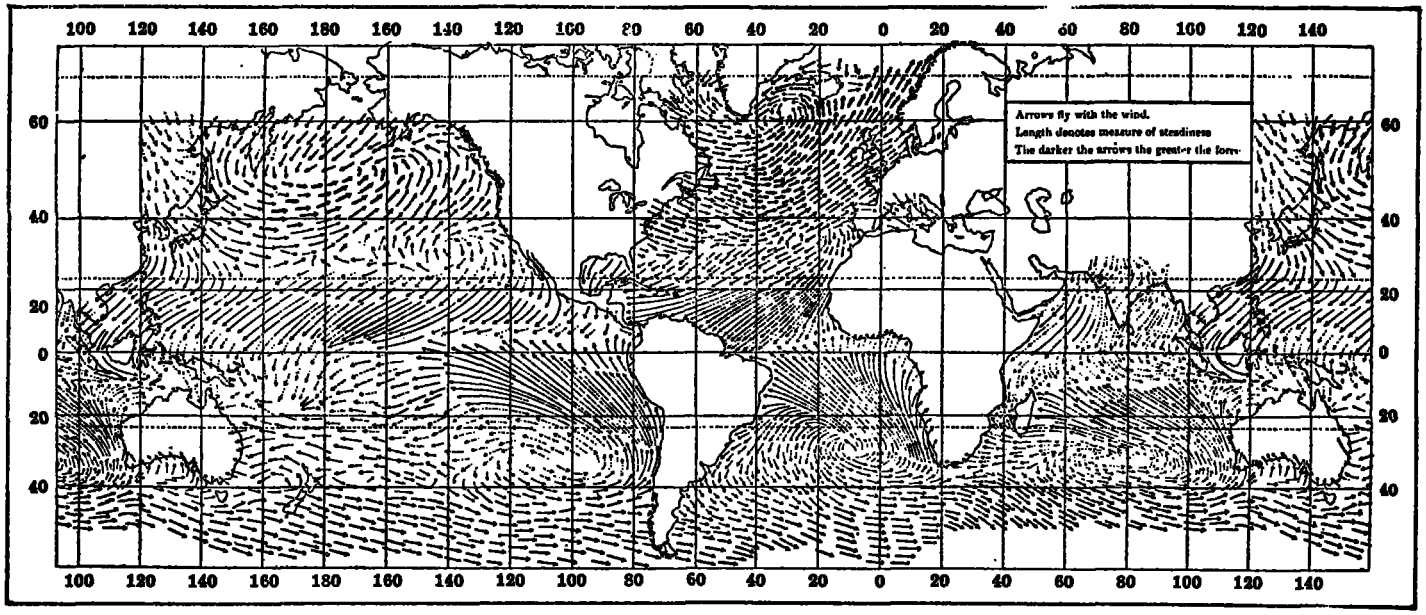

FIG. 3.—Chart of ocean winds in January and February, showing normal directions, relative velocities, and constancies. (Koeppen.)

already 5 p. m. at Paris; six hours later than at St. Louis; seven hours later than at Denver, and eight hours later than at San Francisco. Thus during the longer days of the year as the sun is setting on our western coast it is rising on the following day in eastern France.

Area and topography.—The area of France is slightly less than 210,000 square miles, that of Belgium is about 11,000 square miles, and the combined area of the two countries about equals that of the States along our Atlantic seaboard from North Carolina to New England, inclusive.

The northwestern half of France and practically the whole of Belgium consists principally of low plains and shallow, open valleys, gradually rising from sea level on the west coast toward the interior, with few elevations exceeding 1,000 feet. The eastern and southeastern portions of France are considerably broken, the land rising in the north portion toward the Ardennes, a series of hills and low mountains in southeastern Belgium and northeastern France, with occasional elevations of 2,000 feet or more near the German (Alsatian) frontier. Farther south the Vosges, forming a portion of the boundary between France and Germany, rise to elevations of 5,000 feet or more, while along the borders of Switzerland and Italy the Jura and outlying peaks of the Alps attain elevations somewhat greater. Along the border between France and Spain some of the higher peaks of the Pyrenees reach elevations of more than 10,000 feet.

Important rivers, a number of which are navigable for considerable distances, drain both France and Belgium, which, together with the extensive systems of connecting canals, afford water transportation to large areas of the inland region.

Climate.

France and Belgium, located as they are, in the region of the eastward drift of the atmosphere, afford in their

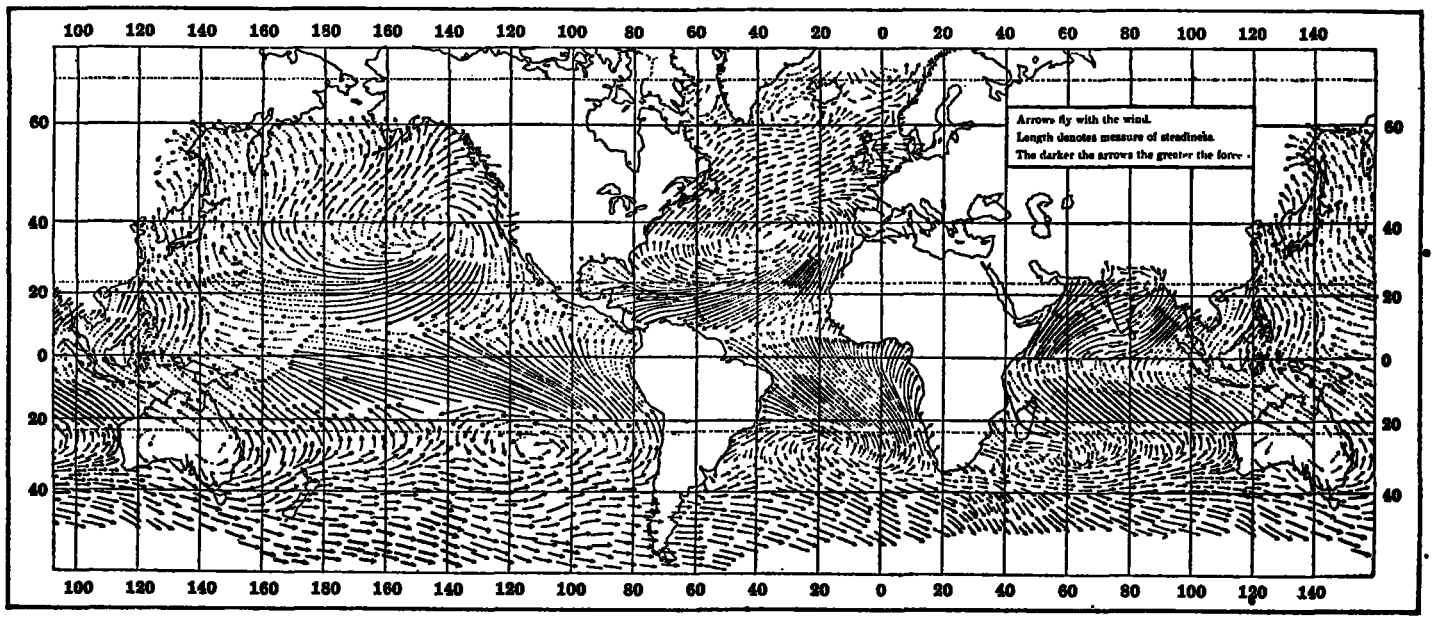

FIG. 4.—Chart of ocean winds in July and August, showing normal directions, relative velocities, and constancies. (Koeppen.)

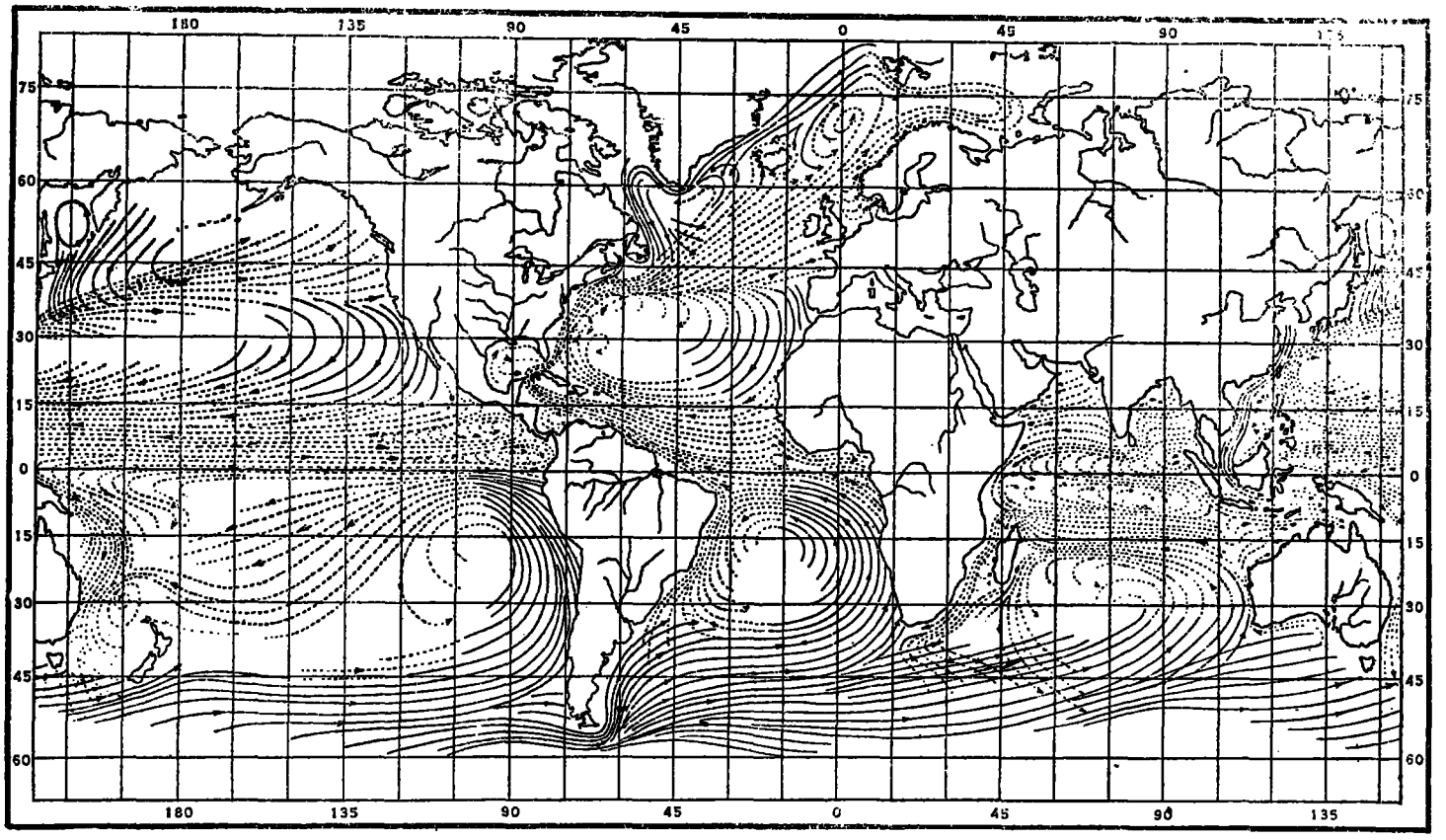

FIG. 5.—Chart of average annual ocean currents. Warm currents indicated by dotted arrows; cooler currents by continuous arrows.

climate an excellent example of the modifying influences exerted upon land areas by the proximity of large bodies of water to their western borders. Water surfaces warm slowly under the direct rays of the sun and also cool slowly in the absence of direct solar radiation, resulting in a comparatively uniform temperature condition. This marine influence is felt in varying degrees over land surfaces adjacent to large bodies of water, its potency and distance reached inland depending on the direction and strength of the surface drift of the atmosphere and the topography of the land. Both the situation and topographic features of France and Belgium are favorable for the marine influence to be felt in a large measure over the greater portion of both countries, the prevailing winds (see figs. 3 and 4) being from off the ocean and with no mountain barriers materially to obstruct their passage to the interior.

The general drift of ocean waters likewise contributes materially to the modification of climate over the adjacent land areas. There are a number of extensive ocean currents which carry large amounts of water for long distances. When these currents have poleward directions they carry relatively warm water into colder regions, and when their flow is equatorward the reverse is true. The great Atlantic Drift, originating in the so-called Gulf Stream, transports relatively warm water from the Gulf of Mexico and adjacent regions into the northeastern portion of the Atlantic Ocean, and the normal westerly winds blowing over these waters carry their warmth to the adjacent land, thus tending to modify further the climate of western Europe. It is of interest to note that while Brest, on the western coast of France, has about the same latitude as Devils Lake, N. Dak., the average January temperature at Brest under these marine influences is 44° F., while at Devils Lake (under continental influences) it is about 0° F. Greater variations are shown in the extremes, where for the vicinity of Brest the lowest observed winter temperature probably does not reach 0° F., while readings of nearly 60 degrees below 0° F. have been observed in the vicinity of Devils Lake. On the other hand, owing to the less rapid cooling of the ocean waters as compared with the land, the ocean winds of summer are cooler than those from the land, and in July the average temperature of Brest is only 64° F., while at Devils Lake it is about 68°.

The general surface drift of the atmosphere over the several oceans in Winter and in Summer is shown by figures 3 and 4, and figure 5 shows broadly the movement of ocean waters. It will be noted from these charts that in the North Atlantic Ocean between Europe and the United States the normal direction of movement for both air and ocean water is northeastward, or toward the European coast.

Temperature.—The outstanding features of the temperature of the countries of western Europe are the comparatively warm winters for such high latitudes, and the relatively cool summers. Along the coasts of northern France and of Belgium temperatures are very similar to those experienced on our own northern Pacific coast, the average monthly temperatures at Dunkirk, France, and at Seattle, Wash., being identical for nearly half the months of the year and differing only slightly for the other months. Farther south over the Atlantic coast districts of France the temperatures throughout the year resemble those of the coasts of southern Oregon and northern California, and during the winter months the averages are not materially different from those of the Carolina and Georgia coasts, but in the latter districts temperatures have a greater variation from day to day and the extremes are decidedly more pronounced. The

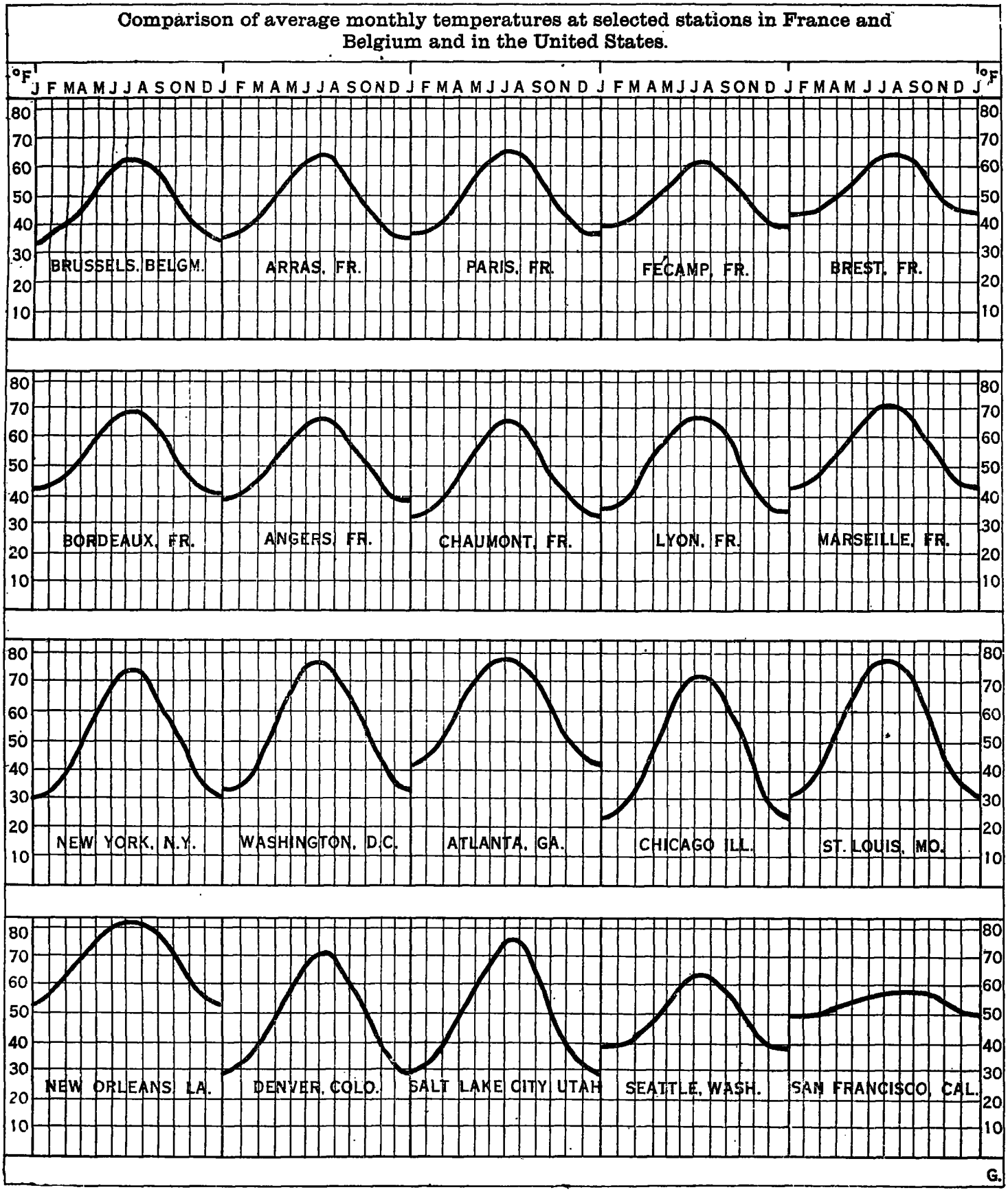

FIG. 6.—Synoptic chart of annual temperature marches at selected stations in France, Belgium, and the United States.

absence of mountain barriers affords the prevailing ocean winds free passage from the coast districts to the interior of these countries; the modifying influences of these ocean winds thus extend far inland, and we find at Paris, for instance, temperature conditions not materially different from those near the coast, nearly 200 miles to the westward.[1]

Over the more eastern districts, where the broken topography and greater elevations interfere with the course of the westerly winds, they no longer exert the strong influence apparent at the lower elevations to the westward, and here we find temperatures showing much wider ranges and conforming more to continental conditions, although the extremes are still far less pronounced than would be expected, considering only the high latitude of the country. Figure 6 presents annual temperature curves for both continents and helps this comparison.

Table 1 shows for a considerable number of stations distributed throughout France and Belgium the average monthly and average annual temperatures, while figure 6 shows graphically similar values for selected points in those countries and in the United States, from which comparisons between different portions of the respective countries can be made. It will be noted by referring to the table and graphs that the chief characteristic of the temperature in France and Belgium is uniformity throughout the year, or the absence of extremely cold weather in Winter and extended hot weather in Summer. The average temperature for the coldest month, January, in the interior of northern France is a few degrees above freezing, corresponding closely to that experienced at about the latitude of southern Missouri and central Virginia in our own country. However, at the latitude named in the United States the fluctuations in temperature from day to day are usually much greater (except on the Pacific coast) during the winter season than in northern France, and the minima usually go considerably lower.

Winter in northern France is not severe from the standpoint of low temperatures, but there is a constancy of moderately cold weather which is not usually experienced in the United States. Table 2 shows for selected stations in France and in the United States the average daily maximum and minimum temperatures, and Table 3 shows for a number of selected points in France the highest and lowest temperatures of record, while Tables 4 and 5 show the average number of days with minimum temperature as low as or lower than 32° F., and the average number with the temperature continuously below 32° F. throughout the day. From Tables 4 and 5 it will be seen that at Arras near the northern end of the battle line (fig. 1) in January about two-thirds of the days on the average have minimum temperatures as low as freezing or lower and, as a rule, about five days of that month have temperatures continuously below freezing. On the Mediterranean coast the winters are delightful, the average January temperature being about 45° F. and freezing weather infrequent. Rather low temperatures sometimes occur in northern France, but such extremely cold weather as is occasionally experienced in the interior and northern portions of the United States is unknown. The coldest weather of record in that region ranges from about 0° F. to −10° F. In the United States "zero weather" has occurred on the central Gulf coast and −10° F. in the northern portions of the central Gulf States, while along the north-central border of the United States, which corresponds closely with the latitude of France (fig. 2), temperatures from 50 to 60 degrees below 0° F. are of record, and the average of the lowest winter temperature is about −35° F.

Summer in northern France and Belgium is cool, as compared with most of the United States, the average temperatures for July and August, the warmest months, being 63° to 65°, even lower than along our northern border. Moderately hot weather sometimes occurs, but extremely high temperatures, such as are occasionally experienced in much of this country, are unknown in France and Belgium. It will be noted from Table 3 that in most of northern France and in Belgium temperatures as high as 100° F. have never been reported, while in the United States 100° to 110° have occurred generally, except in the higher mountain districts and along portions of the coasts. The daily maximum temperatures in northern France and Belgium in midsummer are usually less than 80° and the minimum less than 60° F.

Precipitation.—Table 6 shows for a number of well-distributed stations in France and Belgium, the average monthly and annual precipitation. At the lower elevations the annual precipitation ranges between 20 and 30 inches, but at the higher altitudes, especially at the western extremity of the Pyrenees at the south of France and in the Vosges in eastern France the annual precipitation reaches 60 to 70 inches. The rainfall is rather equally distributed throughout the year, but the maximum amounts occur in the Fall and early Winter and the minimum in the spring months. On the Mediterranean coast rainfall is comparatively heavy during the winter season, but during the summer it is usually very light.

Figure 7 shows graphically for a number of selected stations in France and the United States the average monthly precipitation, permitting comparisons between different portions of the respective countries. Not considering the higher mountains, rainfall in the eastern half of the United States, especially in the South, is much greater than in France and Belgium. Compared with Paris, the average annual rainfall at Chicago is one and one-half times as large; at New York, more than twice as large, and at New Orleans nearly three times as large.

The outstanding feature of rainfall in France and Belgium, when the relatively small totals as compared with the eastern half of the United States are considered, is the frequency of its occurrence. For example, while the average annual rainfall at New Orleans is nearly three times as much as that of Paris, Table 7 shows that rain falls with considerably greater frequency at Paris than at New Orleans. Rainfalls of moderate amounts, 0.25 to 1.00 inch in 24 hours, occur with about as great frequency in France and Belgium as in much of the United States (Table 8), but heavier falls, more than 1.00 inch in 24 hours, rarely occur (Table 9). It will be noted that at Arras, in northern France, only one day had rainfall greater than 1.00 inch during the entire 5-year period from 1907 to 1911, inclusive, while at New Orleans for the same period, amounts of this magnitude were recorded on 63 days.

Snowfall.—In Belgium and over the lowlands of northern France snow is fairly frequent and may be expected from November to April, inclusive, although on account of the rather light character of the precipitation and the moderate temperatures, it rarely attains any considerable depth on the ground. At the higher

[1] A crude comparison between the severity of the winters at Paris and Washington D. C., was published in the MONTHLY WEATHER REVIEW, November, 1914, 42:626-9.—C. A., Jr.

elevations of eastern and southeastern France, particularly in the mountains bordering on Germany and Switzerland where the winters are long and cold, snowfall is more frequent and much heavier and in some places accumulates to considerable depths. At Brussels snow usually occurs on about 25 days during the year, in the vicinity of Paris snow may be expected on about 15 days, while along the English Channel it probably occurs, as a rule, on less than 10 days.

The average number of days with snowfall for each of the winter months and the year at a few selected points in Belgium and northern France, is shown in Table 12, and there compared with points in the United States.

Cloudiness.—The average cloudiness for each month of the year is given for selected stations in France and Belgium and in the United States in Table 11, from which comparisons as to this phase of the weather can be made. The amount of cloudy weather in France during the warm season of the year does not differ materially from that in much of our own country, but in Winter much more cloudy weather is experienced than in most of the United States, this being especially true in northern France and in Belgium. It will be noted from the records for Nice, Marseille, and Montpellier, that there is abundant sunshine in the Mediterranean coast districts at all seasons of the year.

SUMMARY.

From the standpoint of bodily comfort, the climate of northern France and Belgium may be briefly summarized as follows: The winter weather is rather rigorous and unpleasant, due to the persistence of comparatively low temperatures, much cloudiness and frequent rain and snow. The winds blow mostly from the west or southwest and are frequently damp and chilly, the relative humidity being rather high. The winter nights are long and the days correspondingly short. In the extreme northern portion of France, near the present battle line, the sun sets during the latter half of December a few minutes before 4 p. m., and rises about 8 a. m., making the nights, sunset to sunrise, about 16 hours long.

With the transition from Winter to Spring, the rapid warming up familiar to residents in most sections of the United States, is not so noticeable in France and Belgium, the average temperature for March being only 2 to 4 degrees (F.) higher than for February. April and May are moderately cool and not unpleasant, the length of the day increases much more rapidly than in most sections of the United States, and there is a correspondingly large increase in the amount of sunshine, while rainfall is comparatively light, although occurring rather frequently.

The summers are pleasant as compared with much of the United States, the day temperatures being mostly moderate and the nights cool. Occasionally hot weather is experienced, but the heat is not excessive and the periods are usually of short duration. During the latter part of June the days in northern France and Belgium are more than 16 hours long, the sun rising a little earlier than 4 a. m. and setting after 8 p. m.

Fall also is usually pleasant, especially during September and October, the temperature during these months being, as a rule, considerably higher than for the corresponding spring months. With the advent of fall the rainfall usually becomes heavier, resulting more from greater intensity of falls than from increased frequency. This usually is the season of maximum rainfall.

TABLE 1.—*Average monthly temperatures (°F.) for 39 localities in France and 4 in Belgium.*

[For locations see map, figure 1, p. [2].]

Station and dates.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Dunkirk (1881–1900)	39	40	42	47	52	58	63	63	60	52	44	40	50
Lille (1851–1900)	36	38	41	48	54	60	63	63	58	50	42	37	49
Arras (1876–1900)	35	37	41	48	54	60	63	63	57	49	41	36	49
Mézières (1883–1900)	35	37	41	49	55	62	65	64	58	50	41	36	49
Paris (1871–1900)	36	39	43	50	56	62	65	64	59	50	43	37	50
Rouen (1851–1900)	37	39	42	49	55	61	64	63	59	51	43	38	50
Dieppe (1873–1882)	37	39	41	47	51	57	60	61	57	50	43	39	49
Fécamp (1853–1882)	39	40	43	48	52	58	61	62	58	52	45	40	50
Ste. Marie-du-Mont (1871–1900)	40	41	43	48	53	58	62	62	58	52	46	41	50
Guernsey (1851–1900)	43	43	43	47	51	56	59	59	58	53	48	45	50
Saint Malo (1871–1900)	41	42	45	50	54	59	62	62	59	53	46	42	51
Roscoff (1891–1900)	45	45	46	50	54	58	61	62	59	55	49	46	52
Brest (1866–1900)	44	44	46	51	55	60	64	64	61	54	48	45	53
Ernée (1881–1885)	38	40	43	49	54	60	63	62	58	50	43	38	50
Lorient (1862–1900)	43	44	46	51	56	62	65	65	61	54	48	44	53
Belle Ile (1886–1900)	43	43	45	50	55	60	63	64	61	55	49	45	53
Nantes (1856–1900)	40	42	45	51	56	62	66	65	60	53	45	41	52
Angers (1851–1900)	39	41	45	51	57	63	66	66	60	52	45	39	52
Châteaudun (1891–1900)	36	38	42	50	56	62	66	65	59	50	42	36	55
Auxerre (1886–1900)	36	39	43	51	56	64	67	66	60	51	43	36	10
Chaumont (1881–1900)	33	36	41	49	55	62	65	64	58	49	41	34	49
Langres (1891–1900)	32	35	39	48	54	61	64	63	57	48	39	32	48
Besançon (1891–1900)	33	37	42	50	56	63	66	65	60	50	41	34	50
Moulins (1881–1890)	36	38	43	51	57	63	67	66	60	51	42	36	51
Cluny (1881–1890)	35	38	43	51	56	63	67	66	60	51	43	36	51
Annecy (1876–1900)	31	35	41	50	57	64	67	66	60	50	40	32	49
Lyon (1851–1900)	35	39	44	52	58	64	68	67	61	52	42	35	51
Puy-de-Dôme (1881–1900)	28	29	30	35	41	48	52	52	48	40	34	29	39
Menton (1877–1886)	45	46	49	55	61	68	73	73	69	61	52	47	58
Nice (1884–1900)	44	45	48	53	59	66	72	71	66	58	50	45	56
Marseille (1851–1900)	43	45	49	55	61	68	72	71	65	58	50	44	57
Avignon (1872–1884)	39	44	49	56	63	70	75	73	66	57	47	40	57
Montpellier (1851–1900)	41	44	48	54	61	68	73	72	65	57	48	42	56
Perpignan (1851–1900)	44	46	50	56	61	68	73	72	66	58	51	45	58
Toulouse (1851–1900)	40	42	46	52	58	65	73	72	65	57	48	42	56
Agen (1881–1900)	40	42	46	53	58	65	69	69	64	55	46	40	54
Bagnères (1891–1900)	38	42	44	49	54	60	64	64	60	51	44	39	51
Biarritz (1886–1900)	46	48	50	54	59	64	69	69	65	59	51	47	57
Bordeaux (1851–1900)	41	43	47	53	58	64	68	68	64	55	47	41	54
Belgium:													
Ostend....(?)	36	38	42	47	53	59	63	63	60	51	44	39	50
Brussells (1851–1900)	34	36	40	47	53	60	63	62	58	50	41	36	48
Namur (1833–1862)	a35	a36	a40	a48	a56	a64	a66	a65	a57	a50	a40	a37	a50
Liége (1833–1862)	a25	a37	a41	a49	a57	a64	a67	a66	a59	a52	a41	a37	a50

[a] These averages are for 9 a. m. only.

AUTHORITIES:
For French stations: *Bigourdan*—Climat de la France. Paris, 1916.
For Belgian stations: Ostend from *Blanchard*—La Flandre. Paris, 1906.
Brussels from *Hann*—Handbuch der Klimatologie, 3d ed., v. 3. Stuttgart, 1911. p. 192.
Namur and Liége from *Quetelet*—Météorologie de la Belgique. Bruxelles, 1867.

TABLE 2.—*Average daily maximum and minimum temperatures at selected stations in France, Belgium, and the United States.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F.
Fécamp, France (26 years):[1]												
Maximum	43	46	49	55	60	66	69	69	64	58	49	45
Minimum	34	37	38	42	46	51	55	55	52	47	40	36
Sèvres, France, (near Paris, 10 years):[2]												
Maximum	40	44	50	61	66	73	77	75	70	58	49	42
Minimum	32	32	35	41	45	52	55	55	51	43	38	34
Marseille, France (49 years):[2]												
Maximum	52	55	59	65	71	78	83	82	77	68	59	53
Minimum	36	38	41	46	51	57	61	60	56	50	43	38
Brussels, Belgium (12 years):[3]												
Maximum	41	45	48	60	65	72	74	72	67	58	48	42
Minimum	33	36	37	42	48	55	58	58	53	46	38	34
New York, N. Y.:												
Maximum	37	38	45	57	68	77	82	80	74	63	51	41
Minimum	24	24	31	41	52	61	67	66	60	49	38	28
Atlanta, Ga.:												
Maximum	50	53	62	70	79	85	87	85	81	71	61	52
Minimum	35	37	44	51	60	67	70	69	64	53	44	36
Chicago, Ill.:												
Maximum	37	33	42	54	64	74	80	78	72	60	46	36
Minimum	17	18	28	39	49	59	65	65	58	46	33	23
New Orleans, La.:												
Maximum	62	64	71	76	83	88	89	89	86	78	69	63
Minimum	47	49	56	61	68	74	76	75	72	63	54	48
Denver, Colo.:												
Maximum	42	44	52	60	69	80	86	85	77	65	52	45
Minimum	17	20	27	35	44	52	58	57	48	37	26	20
San Francisco, Cal.:												
Maximum	55	58	60	62	63	65	65	65	68	67	62	56
Minimum	45	47	48	49	50	52	52	53	54	54	51	46

[1] From Annales du Bureau Central Météorologique de France, 1885.
[2] From Annales du Bureau Central Météorologique de France.
[3] From *Académie Royal de Belgique*, Observations des Phénomènes Périodiques, 1859–1870.

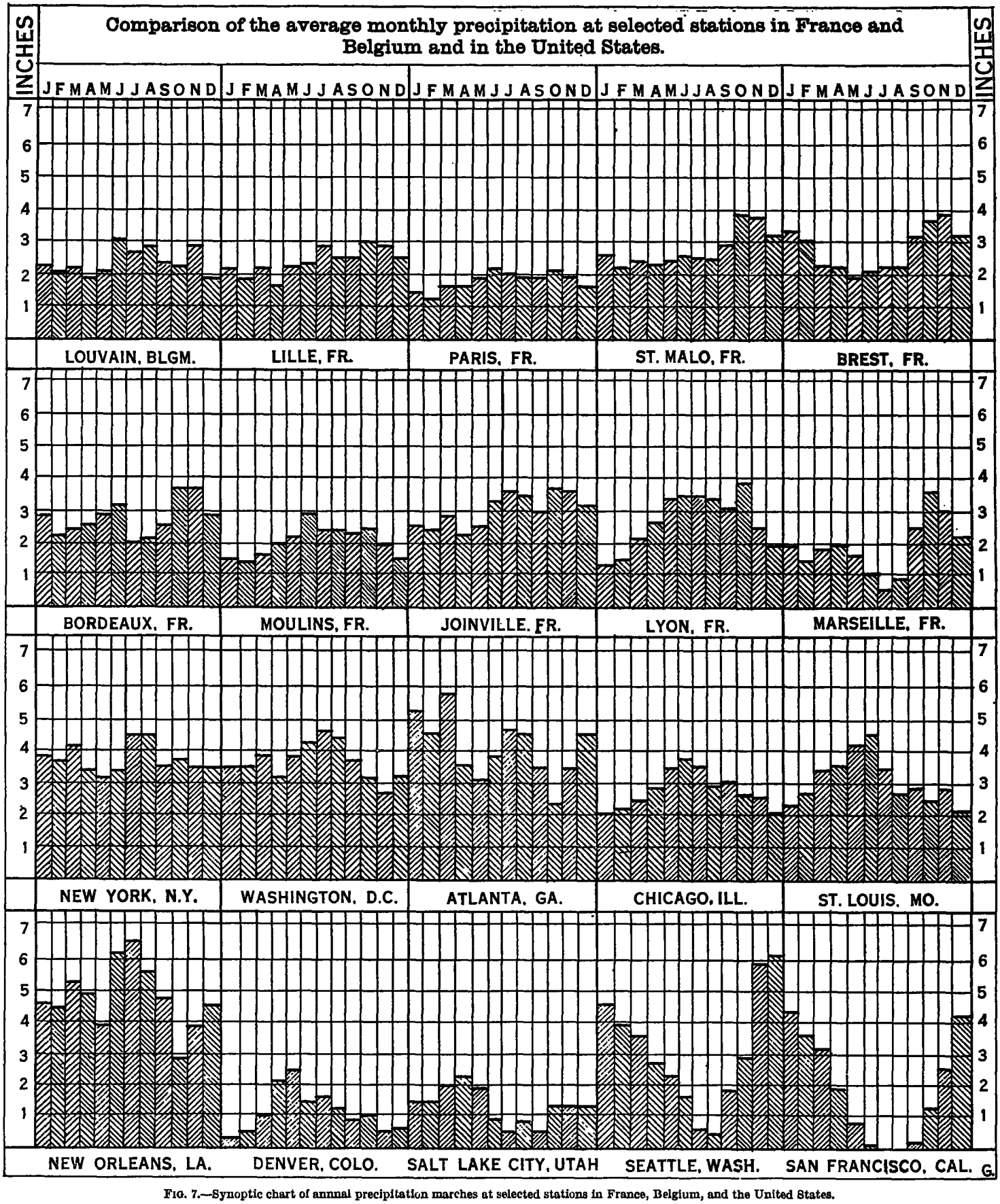

FIG. 7.—Synoptic chart of annual precipitation marches at selected stations in France, Belgium, and the United States.

TABLE 3.—*Highest and lowest temperatures ever recorded at selected stations in France.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
Dunkirk (1881–1900):	°F.	°F.	°F.	°F.	°F.	°F.	°F.	°F	°F.	°F.	°F.	°F	°F.
Highest	56	65	71	75	87	88	89	97	91	77	70	59	97
Lowest	— 1	10	21	32	35	42	45	49	43	30	16	8	— 1
Lille (1851–1900):													
Highest	61	63	72	81	90	96	95	95	91	83	66	63	96
Lowest	0	5	18	27	32	37	39	45	37	22	16	— 2	— 2
Arras (1881–1900):													
Highest	56	64	72	79	91	95	99	96	92	80	68	60	99
Lowest	3	— 4	10	28	28	35	41	36	30	26	6	— 2	— 4
Paris (1851–1900):													
Highest	63	67	75	83	89	95	101	97	97	82	70	62	101
Lowest	7	7	16	26	32	38	43	43	35	26	7	—11	—11
Guernsey (1851–1900):													
Highest	57	59	66	76	77	81	85	87	83	73	66	60	87
Lowest	17	22	27	30	36	41	48	47	40	33	26	24	17
Nantes (1881–1900):													
Highest	64	64	71	83	86	94	102	99	98	83	71	62	102
Lowest	12	5	30	27	30	36	42	39	32	22	18	10	5
Chaumont (1876–1900):													
Highest	61	66	79	83	92	96	104	104	98	83	76	60	104
Lowest	—16	1	2	20	28	34	40	38	29	18	6	— 4	—16
Lyon (1851–1900):													
Highest	66	70	79	83	93	95	101	97	95	82	70	64	101
Lowest	—13	10	4	25	29	36	42	43	32	20	14	— 8	—13
Montpellier (1851–1900):													
Highest	69	77	82	86	94	102	106	102	98	86	76	70	106
Lowest	3	12	14	26	32	39	43	43	35	21	16	3	3
Bordeaux (1881–1900):													
Highest	67	72	78	84	91	96	103	107	98	88	75	67	107
Lowest	3	17	16	29	35	41	47	47	38	37	16	16	3
Brussels, Belgium, (1851–1900):													
Highest	56	65	70	78	91	94	95	95	88	77	68	60	95
Lowest	— 4	2	14	28	31	40	44	45	37	26	11	2	— 4

AUTHORITY: Annales du Bureau Central Météorologique de France, 1904.

TABLE 4.—*Average number of days with a minimum temperature of 32° F. or lower at selected stations in France and the United States.*

Stations.	October.	November.	December.	January.	February.	March.	April.	Annual.	Stations.	Annual.
FRANCE.	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	UNITED STATES.	*das.*
Dunkirk (1881–1900)	0	3	8	10	8	5	0	34	Boston, Mass.	105
Arras (1881–1900)	3	8	15	18	16	12	4	76	Washington, D. C.	89
Paris (1874–1900)	0	5	11	11	10	6	0	43	Cincinnati, Ohio	83
Fécamp (1871–1900)	0	4	8	10	7	4	1	34	Chicago, Ill.	111
St. Marie - du - Mont (1870–1900)	1	4	11	11	8	7	2	44	Kansas City, Mo.	97
Roscoff (1891–1900)	0	0	4	4	3	1	0	12	Minneapolis, Minn.	148
Nantes (1881–1900)	2	5	11	12	12	8	2	52	Bismarck, N. Dak.	182
Angers (1872–1900)	1	4	11	12	9	5	1	43	Denver, Colo.	145
Langres (1889–1900)	2	9	20	20	17	12	4	84	Salt Lake City, Utah.	106
Besançon (1885–1900)	3	9	20	22	18	13	3	88	Helena, Mont.	149
Lyon (1881–1900)	1	6	17	20	15	10	2	71	Seattle, Wash.	22
Nice (1885–1900)	0	0	3	5	4	2	0	14	San Francisco, Cal.	0
Marseille (1867–1900)	0	2	8	9	5	3	0	27	Los Angeles, Cal.	1
Montpellier (1881–1900)	0	2	12	14	10	5	0	43	Santa Fe, N. Mex.	140
Perpignan (1881–1900)	0	1	5	8	4	2	0	20	San Antonio, Tex.	12
Toulouse (1881–1900)	0	3	11	12	8	5	0	39	New Orleans, La.	5
Bordeaux (1881–1900)	1	4	9	11	8	5	0	38	Atlanta, Ga.	39

AUTHORITIES:
Annales du Bureau Central Météorologique de France, 1904.
U. S. Weather Bureau.—Climatological data for the States, 1895–1914.

TABLE 5.—*Average number of days with temperature continuously below freezing at selected stations in France and the United States.*

Stations.	Dec.	Jan.	Feb.	Annual.	Stations.	Annual.
FRANCE.	*das.*	*das.*	*das.*	*das.*	UNITED STATES.	*das.*
Dunkirk (1881–1900)	2	4	2	8	Boston, Mass.	29
Arras (1881–1900)	4	5	2	11	Washington, D. C.	15
Paris (1874–1900)	4	4	3	11	St. Louis, Mo.	80
Roscoff (1891–1900)	0	0	1	1	Chicago, Ill.	47
Nantes (1881–1900)	2	2	1	5	Minneapolis, Minn.	77
Angers (1872–1900)	3	3	1	7	Bismarck, N. Dak.	89
Langres (1889–1900)	11	11	6	28	Denver, Colo.	23
Besançon (1885–1900)	6	8	3	17	Salt Lake City, Utah.	22
Nice (1885–1900)	0	0	0	0	Seattle, Wash.	2
Marseille (1881–1900)	0	1	0	1	San Francisco, Cal.	0
Montpellier (1881–1900)	0	0	0	0	Santa Fe, N. Mex.	14
Perpignan (1881–1900)	0	1	0	1	San Antonio, Tex.	1
Toulouse (1881–1900)	1	2	0	3	New Orleans, La.	0
Bordeaux (1881–1900)	1	2	0	3	Atlanta, Ga.	3

AUTHORITIES:
Annales du Bureau Central Météorologique de France, 1904.
U. S. Weather Bureau—Climatological data for the States, 1895–1914.

TABLE 6.—*Average monthly and annual precipitation at selected stations in France and Belgium.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
France: [a]	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*	*In.*
Dunkirk	2.16	1.51	1.69	1.65	1.89	2.13	2.44	2.87	2.80	3.19	3.23	2.60	28.19
Lille	2.13	1.81	2.20	1.65	2.24	2.28	2.76	2.52	2.52	3.03	2.84	2.48	28.46
Albert	2.00	1.65	1.89	1.54	2.13	2.24	2.68	2.20	2.24	2.48	2.36	2.28	25.69
Paris	1.42	1.10	1.46	1.54	1.85	2.09	1.97	1.85	1.89	2.13	1.89	1.58	20.77
Rouen	2.17	1.69	2.05	1.77	2.09	2.28	2.68	2.48	2.52	2.76	2.68	2.56	27.73
St. Malo	2.72	2.13	2.32	2.21	2.28	2.52	2.44	2.28	2.91	3.78	3.66	3.23	32.48
Brest	3.31	2.95	2.24	2.13	1.93	2.01	2.09	2.13	3.07	3.58	3.78	3.23	32.45
Joinville	2.64	2.52	2.87	2.28	2.52	3.31	3.58	3.35	3.03	3.74	3.62	3.19	36.62
Besançon	3.11	2.60	3.39	3.50	3.90	4.41	3.66	3.50	3.42	4.61	4.09	3.43	43.62
Moulins	1.42	1.31	1.69	2.01	2.21	2.95	2.44	2.40	2.32	2.44	1.89	1.54	24.65
Lyon	1.34	1.42	2.13	2.61	3.27	3.35	3.42	3.27	2.95	3.78	2.56	1.93	32.06
Clermont Ferrand (near Puy-de-Dôme)	1.10	1.14	1.34	1.65	2.36	2.80	2.24	1.67	2.24	2.24	1.50	1.26	21.84
Marseille	1.93	1.38	1.81	2.05	1.57	1.02	0.51	0.59	2.40	3.47	2.99	2.20	22.32
Montpellier	3.46	2.52	2.40	2.52	2.28	1.46	0.91	2.09	2.76	4.53	3.07	2.91	30.91
Toulouse	1.81	1.57	1.97	2.80	2.80	3.07	1.69	1.93	2.28	2.60	1.93	1.65	26.22
Perpignan	1.85	1.65	1.93	1.97	1.93	1.38	0.87	0.91	1.77	2.60	1.38	1.50	19.74
Bagnères	3.66	3.66	4.72	5.12	4.80	5.05	2.42	2.72	3.27	4.20	4.45	3.19	47.32
Bordeaux	2.88	2.28	2.52	2.61	2.91	3.19	2.01	2.16	2.60	3.70	3.66	2.91	33.38
Belgium:													
Ostend [b]	2.05	1.57	1.83	1.54	1.93	1.93	2.24	2.91	2.76	2.56	3.11	2.28	26.77
Ghent [c]	2.28	1.80	2.01	1.93	2.40	2.72	3.11	3.19	2.83	3.39	2.95	2.76	31.46
Louvain [d]	2.28	2.09	2.20	1.93	2.13	3.15	2.68	2.83	2.36	2.28	2.84	1.89	28.66
Namur [e]	1.73	1.42	1.61	1.77	2.05	2.60	2.95	2.84	2.13	2.32	1.97	2.28	25.67
Liége [f]	2.09	1.93	1.97	2.05	2.36	2.79	2.91	3.19	2.48	2.72	2.48	2.52	29.49
Brussels [g]	2.20	1.85	1.97	1.85	2.28	2.52	2.87	3.03	2.56	2.80	2.52	2.40	28.85

[a] Period 1861–1890.
[b] Period 1861–1882.
[c] Period 1838–1874, 1878–1890.
[d] Period 1836–1848.
[e] Period 1849–1863, 1877–1890.
[f] Period 1847–1890.
[g] Period 1833–1896.

AUTHORITIES:
France—Annales du Bureau Central Météorologique de France, 1895.
Belgium—*Lancaster*—La Pluie en Belgique. Bruxelles, 1894.

TABLE 7.—*Average number of days with precipitation, trace or more, for the 5-year period 1907–1911, at selected stations in France and in the United States.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
France:	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*
Nancy	13	16	14	13	14	14	14	12	11	13	17	19	170
Paris	16	17	17	17	17	16	14	11	12	16	16	19	188
Arras	19	19	19	17	15	15	18	14	16	19	22	22	215
Brest	17	16	21	17	13	14	11	11	10	22	20	25	197
Marseille	6	5	12	10	10	8	3	3	8	13	10	13	101
United States:													
New York, N. Y.	18	15	16	15	16	13	10	14	11	11	14	13	166
Washington, D. C.	17	14	16	16	16	16	14	15	11	11	12	13	171
Atlanta, Ga.	13	13	11	14	14	14	19	15	10	8	11	14	156
Chicago, Ill.	19	15	14	18	16	13	13	12	13	11	15	19	178
St. Louis, Mo.	14	14	11	15	15	15	13	11	12	11	9	14	154
New Orleans, La.	10	10	8	12	13	16	20	21	17	9	9	14	159
Denver, Colo.	6	8	8	11	16	13	17	17	12	9	7	9	133
Salt Lake City, Utah.	14	13	14	12	12	11	9	11	9	9	8	14	136
Seattle, Wash.	22	20	18	16	15	12	7	6	11	15	21	20	183
San Francisco, Cal.	21	15	14	8	7	4	3	1	4	7	7	13	102

AUTHORITIES:
France—Annales du Bureau Central Météorologique de France, 1907–1911.
United States—*Weather Bureau*—Climatological data for the States, 1907–1911.

TABLE 8.—*Average number of days with precipitation from 0.25 to 1.00 inch, for the 5-year period 1907–1911, at selected stations in France and the United States.*

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
France:	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*	*das.*
Nancy	2	3	2	1	2	5	4	2	2	4	4	5	36
Paris	1	1	1	2	3	3	2	2	2	5	3	3	28
Arras	3	2	1	3	4	4	3	1	3	5	4	5	37
Brest	3	3	3	2	2	1	2	1	2	6	5	6	36
Marseille	1	1	2	3	1	1	0	1	2	4	3	3	22
United States:													
New York, N. Y.	4	4	3	4	3	4	2	2	3	3	3	3	38
Washington, D. C.	4	4	3	3	4	4	3	3	2	3	3	3	39
Atlanta, Ga.	3	5	3	4	4	4	3	4	3	3	2	4	42
Chicago, Ill.	3	3	3	4	6	4	3	2	2	2	3	3	38
St. Louis, Mo.	2	3	3	4	4	4	2	3	4	2	4	2	37
New Orleans, La.	2	3	1	2	3	4	4	4	5	2	2	3	35
Denver, Colo.	0	0	0	1	3	1	2	3	1	0	1	1	13
Salt Lake City, Utah.	2	3	3	2	4	1	0	2	2	3	2	2	26
Seattle, Wash.	6	5	2	2	3	1	0	0	2	3	6	6	36
San Francisco, Cal.	8	5	5	0	0	0	0	0	0	1	2	4	25

AUTHORITIES: Same as for Table 7 above.

TABLE 9.—*Total number of days with precipitation from 1.01 to 2.00 inches, and with more than 2.00 inches, for the 5-year period 1907–1911, at selected stations in France and in the United States.*

FRANCE.			UNITED STATES.		
Stations.	1.01 to 2.00 inches.	Over 2.00 inches.	Stations.	1.01 to 2.00 inches.	Over 2.00 inches.
	Days.	*Days.*		*Days.*	*Days.*
Nancy	5	0	New York, N. Y.	36	9
Paris	3	0	Washington, D. C.	39	6
Arras	1	0	Atlanta, Ga.	42	8
Brest	1	1	Chicago, Ill.	30	3
Marseille	9	4	St Louis, Mo.	47	4
			New Orleans, La.	63	29
			Denver, Colo.	9	1
			Salt Lake City, Utah	3	0
			Seattle, Wash.	16	0
			San Francisco, Cal.	17	2

AUTHORITIES: Same as for Tables 7 and 8 above.

TABLE 10.—*Average number of days with snowfall, at stations in France and United States.*

Stations.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	Annual.
France:							
Paris—Parc St. Maur (1873–1903)[a]	1	3	4	3	3	1	15
Montdidier (1784–1869)[b]	1	3	4	3	3	1	15
Fécamp (1853–1882)[c]	0	2	2	2	2	0	8
Brussels, Belgium (1833–1850)[d]	1	4	6	5	5	2	23
United States:							
New York							20
Washington							14
Atlanta, Ga							7
Chicago, Ill							30
Kansas City, Mo							19
Oklahoma, Okla							7
Denver, Colo							33

[a] Annuaire de la Société Météorologique de France, 1905 (Paris).
[b] Annales du Bureau Central Météorologique de France, 1895.
[c] Annales du Bureau Central Météorologique de France, 1885.
[d] *Quetelet:* Climat de la Belgique, Bruxelles, 1857.
For the United States, see Table 8 above.

TABLE 11.—*Average cloudiness, in percentages of total sky, at selected station in France and Belgium and in the United States.*

The values given in this table for France and Belgium are averages for the various hours of observation and probably approximate the daily averages, the records in most cases covering periods of at least 10 years. Those for the United States represent the normal average daily cloudiness, *sunrise to sunset*, for a long period of years.

Stations.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
France:	%	%	%	%	%	%	%	%	%	%	%	%	%
Dunkirk	72	71	63	59	57	58	55	63	60	71	79	72	85
Paris—Parc St. Maur	73	72	65	59	56	51	55	49	51	53	62	71	60
Rouen	65	64	58	56	51	52	49	52	58	61	67	67	58
Brest	71	71	70	64	56	67	64	60	61	66	75	64	66
Angers	68	61	57	56	52	53	54	53	56	61	69	69	59
Nantes	75	66	63	64	58	60	57	54	56	61	75	66	63
Besançon	60	64	58	55	51	53	48	48	49	59	65	65	55
Cluny	62	53	57	53	45	43	39	39	39	61	63	65	52
Nice	36	34	32	43	38	29	25	33	33	37	33	34	34
Marseille	47	47	41	46	46	36	23	30	42	44	42	49	41
Montpellier	39	38	36	40	36	31	26	28	35	39	40	41	36
Toulouse	68	57	57	59	57	55	44	45	50	52	61	66	56
Brussels, Belgium	77	78	71	62	63	67	63	65	58	65	75	79	69
United States:													
New York	58	54	56	54	53	51	51	51	48	48	54	56	53
Washington	58	54	55	50	50	48	46	48	45	45	51	54	50
Atlanta	57	55	51	49	47	50	54	54	47	38	45	53	50
Chicago	59	56	57	52	48	47	40	40	43	48	58	61	52
St. Louis	53	54	55	51	50	48	44	39	38	35	51	58	48
New Orleans	54	53	49	47	44	47	52	50	43	38	46	53	48
Denver	37	40	46	49	52	41	44	44	35	36	37	38	41
Salt Lake City	59	58	55	51	47	34	30	34	30	38	47	58	45
Seattle	77	71	64	60	65	58	42	42	56	67	75	79	63
San Francisco	53	49	48	41	40	35	41	43	33	35	42	50	43

AUTHORITIES:
France—Annales du Bureau Central Météorologique de France, 1884.
United States, as above.

TABLE 12.—*Prevailing wind directions and average relative humidities for Sèvres, Brussels, and Montpellier.*

	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
	Prevailing winds.												
Sèvres (10 years)	SW	SW	W	SW	NE	W	W	W	W	SW	SW	SW	SW
Brussels (8 years)	SW	SW	SW	SW	SW	N	SW	SW	SW	SW	SW	SW	SW
	Average relative humidity.												
Sèvres (10 years)	%	%	%	%	%	%	%	%	%	%	%	%	%
7 a. m.	89	89	89	79	73	72	76	82	90	94	92	92	....
12 noon	78	69	60	51	51	51	54	55	58	68	76	80	....
9 p. m.	86	82	78	72	74	76	77	79	83	90	90	89	....
Montpellier (14 years):													
9 a. m.	82	76	70	67	62	58	56	57	66	71	80	80	....

AUTHORITIES: Annual reports of the French and Belgian meteorological services.

551.575 (794)

FOG ALONG THE CALIFORNIA COAST.

By ANDREW H. PALMER, Observer.

[Dated: Weather Bureau office, San Francisco, Cal., Oct. 15, 1917.]

When the Marine Exchange of the San Francisco Chamber of Commerce was asked what proportion of shipwrecks occurring along the California coast was due to fog, the reply was, "All of them." That exchange keeps a detailed record of all marine disasters occurring in the Pacific Ocean. The records previous to 1906 are no longer available, as they were destroyed in the fire which followed the San Francisco earthquake of April 18, 1906. But the record kept since that date is voluminous, for many shipwrecks have occurred. A cursory examination of this record showed that nearly all of those which occurred along the California coast were indirectly due to fog. The winds along the coast of California, though occasionally strong, are seldom of destructive violence. Hurricanes are practically unknown. Storms of the type which sweep the Atlantic coast of the United States every winter are of rare occurrence. At Point Reyes local winds often exceed 100 miles per hour in velocity, and the records include some of the highest winds ever recorded at sealevel in the United States. But these velocities, while true, are restricted to the immediate vicinity of the Point, and never occur along the routes followed by steamers. Along the California coast, clear-weather gales seldom cause more inconvenience to shipping than delayed schedules. But fog, which is unfortunately of frequent occurrence, and often of long duration, is a serious obstacle, and is without question the greatest menace to navigation.

Though there has been an increasing demand on the part of mariners for trustworthy fog data, the Weather Bureau, until recently, has been unable to render effective service in this matter. Though situated near the coast, the regular Weather Bureau stations at Eureka, San Francisco, San Luis Obispo, Los Angeles, and San Diego were nevertheless too far removed from the steamer lanes to secure the desired data. However, during the